Mississippi Transitional Refresher Course
Pharmocotheraputics Course Outline

Minimum course length 12 hours

1. Sources of drugs:
    1. Plant Sources
        1. Leaves, roots, seeds, and other plant parts may be processed for use as drugs.
        2. Example: Atropine, obtained from the plant called deadly nightshade. (its scientific name is *Atropa belladonna*).
    2. Animal Sources
        1. Some of the most powerful drugs are extracted from animal tissue.
        2. Often used to replace insufficient glandular secretions.
        3. Example: Insulin, a hormone extracted from the pancreas of pork or beef.
    3. Inorganic Sources (Minerals or mineral products.)
        1. Sulfur, iodine and mineral salts are commonly used to manufacture drugs.
        2. Most common pre-hospital drug made from mineral sources is sodium bicarbonate, used to treat metabolic acidosis.
        3. Magnesium sulfate, used to treat eclampsia, is a naturally occurring mineral commonly obtained from well and sea water.
    4. Synthetic Sources (Chemicals made in the laboratory.)
        1. Man made, by chemical processes.
        2. Most drugs are synthetic.
        3. Example: Lidocain
2. Bringing New Drugs to Market
    1. Initial drug testing begins with toxicity study on both male and female mammals.
    2. Then it is designated an investigational new drug. (IND)
    3. Human studies then take place in four phases.
3. Phases of Human Studies

1. Phase 1:

    1. To determine the drug's pharmacokinetics, toxicity, and safe dose in humans. Limited populations of healthy human volunteers.

2. Phase 2:

    1. To determine the therapeutic drug level and watch for toxic side effects. Tested on limited populations of patients who have the disease it is intended to treat.

3. Phase 3:

    1. To refine the usual therapeutic dose and collect data on side effects. Requires a larger patient population. Studies are usually double blind.

4. Phase 4:

    1. Involves post-marketing analysis during conditional approval.

4. FDA Classification of New Drugs

    1. Utilizes a number and a letter for each new drug.
    2. Numerical Classification (Chemical)

        1. Assigned a number 1-7

    3. Letter Classification (Treatment or Therapeutic Potential)

    4. Other Classifications

5. Drug References

    1. Provide information on various drugs, their preparation and recommended administration

        1. American Medical Association (AMA) Drug Evaluation
        2. Hospital Formulary
        3. Medication package inserts
        4. Physician's Desk Reference (PDR)

6. Laws affecting drug administration.

    1. The Pure Food & Drug Act of 1906

1. Enacted to improve the quality and labeling of drugs.

2. Harrison Narcotic Act of 1914

    1. Limited the indiscriminate use of addicting drugs by regulating the importation, manufacture, sale, and use of opium, cocaine, and their compounds or derivatives.

3. The Federal Food, Drug and Cosmetic Act of 1938.

    1. Empowered the FDA to pre-market safety standards for drugs. Amended in 1951 by the *Durham-Humphrey Amendments* to require written or verbal prescriptions from a physician to dispense certain drugs.

4. Comprehensive Drug Abuse Prevention and Control Act. Of 1970. (AKA Controlled Substances Act)

    1. Most recent major federal legislation affecting drug sale and use. Replaced the Harrison Narcotic Act of 1914.

7. Schedules of Drugs

    1. Schedule I

        1. High abuse potential. No accepted medical indications.

            1. Examples: Heroin, LSD, mescaline

    2. Schedule II

        1. High abuse potential. Accepted medical indications

            1. Examples: Opium, cocaine, morphine, codeine, oxycodone, methadone, secobarbital.

    3. Schedule III

        1. Less abuse potential than schedule II or II; may lead to moderate or low physical dependence.

        2. Limited opioid amount or combined with non-controlled substances.

            1. Examples: Vicodin, Tylenol w/ codeine.

    4. Schedule IV

        1. Low abuse potential compared to schedule III. Limited psychosocial

and/or physical dependence.

2. Examples: Diazepam, lorazepam, phenobarbital.

5. Schedule V

1. Lower abuse potential than schedule IV. May lead to psychosocial and/or physical dependence.

2. Limited amounts opioids; often for cough or diarrhea.

8. Drug Profiles

1. Components

1. Names
2. Classification
3. Mechanisms of Action
4. Indications
5. Pharmacokinetics
6. Side effects
7. Routes of Administration
8. Contraindications
9. Dosage
10. How supplied
11. Special considerations

9. Patient Care with Medications

1. Know the Drug profile.
2. Practice proper technique.
3. Know how to observe and document effects.
4. Maintain current knowledge in pharmacology.
5. Establish and maintain professional relationships with other health care providers.
6. Understand pharmacokinetics & pharmacodynamics.
7. Have current drug references available.
8. Take careful drug histories.
9. Evaluate the compliance, dosage, and adverse reactions.
10. Consult with medical direction when appropriate.

10. Six Rights of Medication Administration

1. Right medication
2. Right dose
3. Right time
4. Right route
5. Right patient

6. Right documentation

11. Special Considerations

1. Pediatric Patients

1. Neonates (Infants from birth to 4 weeks) metabolism and excretion may be impaired.

2. Children up to one year have diminished plasma protein concentrations.

3. Results in higher free drug availability with drugs that bind to proteins.

4. Many factors cause a pediatrics drug function to differ radically from an adults.

5. The Broselow tape primarily addresses drugs administered in the critical care setting.

2. Geriatric Patients

1. Common physiological effects of aging:

1. Decreased cardiac output
2. Decreased renal function
3. Decreased brain mass
4. Decreased total body water
5. Decreased body fat
6. Decreased serum albumin
7. Decreased respiratory capacity

2. These changes can lead to:

1. Altered pharmacodynamics & pharmacokinetics.

2. Decreased rates of metabolism and excretion.

3. Decreased protein binding because of decrease level of serum albumin.

3. Result – Dosages may have to be decreased.

4. Elderly also suffer from multiple disease processes.

5. May be on chronic medications that can affect emergency medications.

3. Pregnant Patients
    1. Anatomical & Physiological changes.
        1. Increased cardiac output
        2. Increased heart rate
        3. Increased blood volume (up to 45%)
        4. Decreased protein binding
        5. Decreased hepatic metabolism
        6. Decreased blood pressure
    2. Drug has the potential to cross the placenta and affect the fetus.
    3. Drug therapy can affect a breast-feeding infant.

12. Paramedics responsibilities in administration of medications.
    1. Paramedics are personally, legally, morally and ethically responsible for the safe administration of medications.
        1. Know the precautions and contraindications for all medications you administer.
        2. Practice proper technique.
        3. Know how to observe and document drug effects.
        4. Maintain a current knowledge in Pharmacology.
        5. Establish and maintain professional relationships with other health care providers.
        6. Understand the pharmacokinetics and pharmacodynamics.
        7. Have current medication references available.
        8. Take careful drug histories including:
            1. Name, strength, and daily dose of prescribed drugs
            2. Over-the-counter drugs
            3. Vitamins
            4. Herbal medications
            5. Folk-medicine or folk remedies
            6. Allergies
        9. Evaluate the compliance, dosage, and adverse reactions.

10. Consult with medical direction when appropriate.

13. Pharmacokinetics

1. Strictly defined, pharmacokinetics is the study of the basic processes that determine the duration and intensity of a drug's effect.

2. Pharmacokinetic Processes

1. Absorption
2. Distribution
3. Biotransformation
4. Elimination

3. Physiology of Transport

1. Active transport

1. Requires the use of energy to move a substance.

2. Carrier mediated diffusion,

1. AKA facilitated diffusion

2. Process in which carrier proteins transport large molecules across the cell membrane.

3. Passive transport

1. Movement of a substance without the use of energy.

4. Diffusion

1. Movement of solute in a solution from an area of higher concentration to an area of lower concentration.

5. Osmosis

1. Movement of solute in a solution from an area of lower solute concentration to an area of higher solute concentration.

6. Filtration

1. Movement of molecules across a membrane from an area of higher pressure to an area of lower pressure.

4. Absorption
    1. The process of movement of a drug from the site of application into the body and into the extra-cellular compartment.
        1. Affected by many factors including:
            (1) Solubility of the drug
            (2) Concentration of the drug
            (3) pH of the drug (Actually the pH of the patient has more to do with this.)
            (4) Site of absorption
            (5) Absorbing surface area
            (6) Blood supply to the supply to the site of absorption
            (7) Bioavailability
                (1) Comparison of Rates of Drug Absorption of Various Routes of Administration

	Route	Rate of Absorption
1)	Oral	Slow
2)	Subcutaneous	Slow
3)	Topical	Moderate
4)	Intramuscular	Moderate
5)	Intralingual	Rapid
6)	Rectal	Rapid
7)	Sublingual	Rapid
8)	Endotracheal	Rapid
9)	Inhalation	Rapid
10)	Intraosseous	Immediate
11)	Intravenous	Immediate
12)	Intracardiac	Immediate

5. Distribution
    1. The process whereby a drug is transported from the site of absorption to the site of action.
        1. Affected by several factors:
            (1) Cardiovascular function

(2) Regional blood flow
(3) Drug storage reservoirs
(4) Physiological barriers
(5) Blood-brain barrier
(6) Placental barrier

6. Biotransformation

    1. A special name for metabolism.

    2. Metabolism

        1. The body's breaking down chemicals into different chemicals.

    3. Has one of two effects on drugs.

        1. It can transform the drug into a more or less active metabolite.

        2. It can make the drug more water soluble (or less lipid soluble) to facilitate elimination.

    4. Biotransformation process:takes place in:

        1. The liver.

        2. Microsomal enzymes in the endoplasmic reticula of hepatocytes (liver cells).

        3. Kidney Lung and GI tract

    5. First-pass effect.

        1. Blood supply from the GI Tract passes through the liver before moving on through the systemic circulation.

        2. First pass may completely inactivate many drugs.

        3. These drugs must be given IV rather than orally.

    6. Biotransformation begins immediately following introduction of the drug.

        1. Certain drugs are rapidly transformed.

        2. Epinephrine is active as administered and rapidly metabolized to inactive forms.

(1) Must be administered every 3-5 minutes.

7. The livers microsomal enzymes react with drugs in two ways:

    1. Phase-I (non-synthetic reactions.)

        (1) Most often oxidize the parent drug.
        (2) May reduce or hydrolyze the drug.

    2. Phase II (synthetic reactions.)

        (1) AKA conjugation reactions, combine the prodrug or its metabolites with an endogenous chemical, usually making the drug more polar and easier to excrete.

7. Elimination

    1. Refers to movement of a drug or its metabolites from the tissues back into the circulation and to the organs of excretion.

        1. Kidneys via urine
        2. Liver via bile
        3. Intestines into the feces.
        4. Lungs via expired air.
        5. Sweat, saliva, and breast milk.

    2. Eliminated in original form or as metabolites.

    3. Elimination is affected by:

        1. Drug half-life

            (1) The time required for the total amount of the drug in the body to diminish by one-half.

        2. Accumulation

            (1) Example: Digoxin.

        3. Clearance

            (1) Refers to the removal of a drug from the body.

8. Onset, peak, and duration.

    1. Determined primarily by its bio-availability and drug concentration in the blood.

9. Drug Routes

    1. Enteral

        1. Absorption through the GI tract.

        2. Enteral Routes

            (1) Oral (PO)
            (2) Orogastric/nasogastric tube (OG/NG)
            (3) Sublingual (SL)
            (4) Buccal
            (5) Rectal (PR)

        3. Advantages

            (1) Simple
            (2) Safe
            (3) Generally less expensive
            (4) Low potential for infection.

        4. Disadvantages

            (1) Slow rate of onset

            (2) Cannot be given to unconscious of nauseated patients.

            (3) Absorbed dosage may vary significantly because of actions of digestive enzymes and the condition of the intestinal tract.

    2. Parenteral Routes

        1. Broadly defined, any area outside of the GI tract.

        2. Parenteral Routes

            (1) Topical
            (2) Intradermal
            (3) Subcutaneous
            (4) Intramuscular
            (5) Intramuscular
            (6) Intravenous
            (7) Endotracheal
            (8) Sublingual injection

(9) Intracardiac
(10) Intraosseous
(11) Inhalation
(12) Umbilical
(13) Vaginal

10. Drug Forms

1. Solid
2. Pills
3. Powders
4. Tablets
5. Suppositories
6. Capsules
7. Liquid
8. Solutions
9. Tinctures
10. Suspensions
11. Emulsions
12. Spirits
13. Elixirs
14. Syrups

14. Pharmacodynamics

1. Is the study of mechanisms by which specific drug dosages act to produce biochemical or physiological changes in the body.

2. Actions of Drugs

1. Can act in four different ways:

1. Bind to a receptor site.
2. Change the physical properties of cells.
3. Chemically combine with other chemicals.
4. Alter a normal metabolic pathway..

2. Binding To A Receptor Site

1. A receptor is a specialized protein that combines with a drug resulting in a biochemical effect.

2. Affinity

(1) Force of attraction between a drug and a receptor.

3. Efficacy
    (1) A drugs ability to cause the expected response.

3. Second messenger:

    1. Chemical that participates in complex cascading reactions that eventually cause a drug's desired effect.

4. Down-regulation

    1. Binding of a drug or hormone to a target cell receptor that causes the number of receptors to decrease.

5. Up-regulation

    1. A drug causes the formation of more receptors than normal.

6. Stimulation of A Receptor Site

    1. Chemicals that stimulate fall into two broad categories:

        (1) Agonist

            (1) Causes it to initiate the expected response.

        (2) Antagonist

            (1) Causes the drug not to initiate the expected response.

        (3) Some drugs do both.

            (1) Called agonist-antagonist AKA Partial agonist.

    2. Competitive antagonism:

        (1) One drug binds to a receptor and causes the expected effect while also blocking another drug from triggering the same receptor.

    3. Non-Competitive antagonism:

        (1) The binding of an antagonist causes a deformity of the binding site that prevents an agonist from fitting and binding.

4. Irreversible antagonism:
    (1) A competitive antagonist permanently binds with a receptor site.

7. Other Actions of Drugs

1. Changing Physical Properties:

(1) Osmotic balances across membranes are good examples. (ie: Mannitol, Osmotrol)

2. Chemically combining with other substances.

(1) Drugs that participate in chemical reactions that change the chemical nature of their substrates.

3. Altering a normal metabolic pathway:

(1) The anticipated product will not form of, if formed, will be substantially or completely inactive.

3. Responses to Drug Administration

1. Side effect
2. Allergic reaction
3. Idiosyncrasy
4. Tolerance
5. Cross Tolerance
6. Tachyphylaxis
7. Cumulative effect
8. Drug dependence.
9. Drug interaction
10. Drug antagonism
11. Summation
12. Synergism
13. Potentiation
14. Interference

4. Drug Response Relationship

1. Correlates different amounts of drug to the resultant clinical response.

2. Plasma-level profile

1. Describes the lengths of onset, duration, and termination of action, as well as the drug's minimum effective concentration and toxic

levels.

3. Factors Altering Drug Response

    1. Age
    2. Body Mass
    3. Sex
    4. Environment
    5. Time of Administration
    6. Pathologic state
    7. Genetic factors
    8. Psychological factors

5. Drug Interactions

    1. Variables that may cause drug-drug interactions:

        1. One drug could alter the rate of intestinal absorption.

        2. The two drugs could compete for plasma protein binding, resulting in one's accumulation at the other's expense.

        3. One drug could alter the other's metabolism, thus increasing or decreasing either's bioavailability.

        4. One drug's action at a receptor site may be antagonistic or synergistic to another's.

        5. One drug could alter the other's rate of excretion through the kidneys.

        6. One drug could alter the balance of electrolytes necessary for the other drug's expected result.

15. Administering medications through a gastric tube.

    1. Indications

        1. Patients who have difficulty swallowing or nutritional status is poor.

    2. Equipment

        1. A 100 ml Cone-tipped syringe
        2. A 30-50 ml Cone-tipped syringe for medication.
        3. 50-100 ml of Normal Saline

    3. Technique

1. Confirm proper tube placement.

2. Withdraw the plunger while observing for the presence of gastric fluid contents.

3. Instill medication into the gastric tube.

4. Gently inject the saline

5. Clamp off the distal tube.

4. Precautions

1. Avoid administering time released medications.

1. Crushing of medication destroys its slow release mechanism.

16. Administering medications rectally

1. Drugs given rectally do not pass through the liver and therefore do not undergo hepatic alteration (first pass effect).

2. Technique:

1. Confirm the indication for administration and dose, and draw the correct quantity of medication into a syringe.

2. Place the hub of a 14-gauge Teflon catheter (removed from the angiocatheter) on the end of a needleless syringe.

3. Insert the Teflon catheter into the patient's rectum and inject the medication in the lower part of the rectum. Administration higher in the rectum may result in the medication's being absorbed by veins that deliver the drug to the portal circulation.

4. Withdraw the catheter and hold the patient's buttocks together thus permitting retention and absorption.

17. Disposal of contaminated sharps.

1. Preparedness is the key to proper disposal of sharps in the pre-hospital environment.

1. Have a small sharps container in your jump kit or drug box.

2. Make sure all sharps container on ambulance and kit are not filled and lids are in good working condition.

3. Properly close and replace any sharps containers needing to be changed.

2. Sharps disposal must be completed immediately after administrating medication.

1. Never lay sharps on the ground or stick them into the ground.

2. Never stick sharps into the bench seat or any other surface in the ambulance.

3. Needle handling precautions

1. Minimize task in a moving ambulance
2. Properly dispose of all sharps
3. Recap needles only as a last resort

18. Drugs used to affect the Nervous system

1. Many pathological conditions involve the central nervous system (CNS).
2. As a result, many drugs have been developed to affect the CNS.

19. Autonomic Division of the Peripheral Nervous System

1. Anatomical and physiological differences with the autonomic division of the peripheral nervous system are the basis for its further subdivision into sympathetic and parasympathetic components

1. Cell bodies of the neurons in these two divisions are located in different areas of the CNS and leave at different levels.

1. The sympathetic from the thoracic and lumbar regions of the spinal cord.

2. The parasympathetic from the cranial and sacral portions of the spinal cord

2. Perhaps it will help if you can remember that the sympathetic and parasympathetic components of the nervous system are like the brakes and accelerator in a car--always working to keep the body at a certain "speed."

3. The heart, many glands, and smooth muscles are innervated by both sympathetic and parasympathetic nerve fibers.

20. Preganglionic and Postganglionic Neurons.

1. Autonomic intervention by the sympathetic and parasympathetic nervous system may be viewed as involving a two-neuron chain that exists in a series between the CNS and the effector organs.

    1. The two-neuron chain comprises a preganglionic neuron located in the CNS and a postganglionic neuron located in the periphery.

        1. The preganglionic fibers pass between the CNS and ganglia

        2. The postganglionic fibers pass between the ganglia and the effector organ.

    2. Many of the sympathetic ganglia lie close to the spinal cord and others lie approximately midway between the spinal cord and the effector organ.

    3. The parasympathetic ganglia lie close to or within the walls of the effector organ

    4. A synapse is the anatomical area that serves as a functional junction between these two neurons

21. Cholinergic and Adrenergic Fibers

    1. Acetylcholine (Cholinergic)

        1. The neurotransmitter for the ganglionic synapse between preganglionic and postganglionic fibers of the sympathetic and parasympathetic divisions.

        2. The neurotransmitter at the junction between the parasympathetic postganglionic fiber and the effector cell.

        3. Fibers that release acetylcholine are known as cholinergic fibers.

        4. All preganglionic neurons of the sympathetic division and all postganglionic neurons of the parasympathetic division are cholinergic

    2. Norepinephrine (Adrenergic)

        1. The neurotransmitter between the sympathetic postganglionic fiber and the effector cell.

        2. Fibers that release norepinephrine are adrenergic fibers.

        3. Most postganglionic neurons of the sympathetic division are adrenergic;

few are cholinergic.

4. Norepinephrine is a member of the catecholamine family. It was previously known as noradrenalin, hence the name adrenergic.

22. The actions of the autonomic nervous system depend on the neurotransmitter released by the ganglionic cells and the effector cells receptor site.

    1. Stimulation of the sympathetic nerves causes excitatory effects in some organs and inhibits effects in others.

    2. Likewise, parasympathetic stimulation causes excitation in some organs but inhibition in others.

    3. Both systems function continuously and occasionally react in a reciprocal fashion.

    4. Most organs are dominantly controlled by one of the two systems.

    5. As a rule, the sympathetic system dominates during stressful events. i.e.: Fight, flight, or fright syndrome.

    6. The parasympathetic system is most active during periods of emotional and physical calm.

23. Transmission of Nerve Impulses

    1. The occurrence of neurotransmitters and a number of different receptors provides the basis in response of sympathetic and parasympathetic nerves.

    2. For cholinergic synapses, acetylcholine molecules combine with other cholinergic receptor molecules (nicotinic and muscarinic)

        1. Nicotine specifically binds to and activates nicotinic receptors but not muscarinic receptors.

            1. Nicotine is an alkaloid substance found in tobacco.

        2. Muscarine specifically binds to and activates only muscarinic receptors.

            1. Muscarine is an alkaloid extracted from poisonous mushrooms.

        3. When acetylcholine binds to nicotinic receptors, there is an excitatory response.

        4. When it binds with muscarinic receptors, it may result in excitation or inhibition, depending on the target tissues in which the receptors are

found.

1. Acetylcholine binding to muscarinic receptors in cardiac muscle causes reduced heart rate

2. Acetylcholine binding to muscarinic receptors in smooth muscle cells of the GI tract causes an increased rate and amplitude of contraction.

5. Atropine blocks muscarinic but not nicotinic receptor sites, thereby affecting heart rate while not causing paralysis.

6. Curare is a nicotinic receptor blocker, causing paralysis.

3. For adrenergic synapses, norepinephrine molecules combine with adrenergic receptor molecules within the membranes of the effector organ (alpha receptors and beta receptors).

1. Norepinephrine binds to and activates both types of receptor molecules.

1. Has more affinity for alpha receptors.

2. Epinephrine (produced by the adrenal medulla) is an adrenergic substance.

1. Has nearly equal affinity for both receptors

3. In tissues containing alpha and beta receptor cells, one type is more abundant and has a dominating effect.

4. Both receptors can be excitatory or inhibitory.

1. Beta receptors are stimulatory in cardiac muscle, but inhibitory in intestinal smooth muscle.

24. Drugs Affecting the Cardiovascular System

1. Pharmacological Terms to Describe Actions of Cardiovascular Drugs

1. Chronotropic drugs

1. Affect heart rate

2. A drug that accelerates heart rate is said to have a positive chronotropic effect (isoproterenol)

3. A drug that decreases the heart rate is said to have a negative chronotropic effect (verapamil)

2. Dromotropic drugs

    1. Affect conduction velocity through the conducting tissues of the heart

    2. If a drug speeds conduction, it is said to have a positive dromotropic effect (isoproterenol)

    3. If a drug slows conduction, it is said to have a negative dromotropic effect (adenosine)

3. Inotropic drugs

    1. Affects force of contraction

    2. A drug that strengthens or increases the force of contraction is said to have a positive inotropic effect (epinephrine)

    3. A drug that weakens or decreases the force of contraction is said to have a negative inotropic effect (propranolol)

25. Review of Cardiac Anatomy

1. Essentially a two sided pump.

    1. Right side is a low pressure.
    2. Left side is a high pressure.

2. Cardiac Output

    1. Determined by Stroke Volume and Heart Rate.
    2. Cardiac Output = Heart Rate X Stoke Volume
    3. The “Atrial Kick” can increase cardiac output by up to 25%

3. Cardiovascular Physiology Review

    1. Impulse generation and conduction.

        1. The heart is composed of many interconnected branching fibers or cells that form the walls of the two atria and two ventricles.

        2. Some cells are specialized to conduct electrical impulses

        3. Some have contraction as their primary function.

4. Cardiac drugs are classified by their effects on these tissues.

4. Depolarization;

1. The process of eliminating or reversing the charge across a cell membrane.

1. Fast action potential.

(1) Found in cardiac muscle tissue.

(2) Cyclic activity has five phases.

(1) Phase 0

1) Represents depolarization.

2) Results from rapid influx of Na+ ions causing the inside of the cell to become more positive.

3) Normally caused by the arrival of an impulse generated somewhere else in the heart.

(2) Phase 1

1) K+ begins to leave the cell.

2) Returning the cell to its normal negative charge.

(3) Phase 2

1) Interrupts Phase 1 with an influx of Ca++ into the cell.

2) AKA the Plateau phase.

3) Delays repolarization.

4) Important for medications that affect the strength of contractions.

(4) Phase 3

1) Marked by the cessation of calcium influx and rapid efflux of K+.

(5) Phase 4

1) Normally a flat stage representing the resting membrane potential.

2) In Pathologic states, a slow influx of Na+ that will gradually make the cell more positive.

3) When the interior of the cell reaches its threshold potential, the cell will depolarize without waiting for an impulse.

4) Many antidysrythmics have their mechanism of action during this phase.

2. Slow action potential.

(1) Located in the dominant pacemakers of the heart.

(2) Caused by a gradual influx of calcium in the cell.

(3) Slow potentials undergo a gradual, phase 4 depolarization.

(1) Responsible for the spontaneous generation of impulses in the SA and AV nodes.

(2) Because the SA node has a faster rate of depolarization, it is the dominant pacemaker.

5. Dysrhythmia Generation

1. Cardiac rhythm disturbances may be caused by:

1. Ischemia
2. Hypoxia
3. Acidosis or alkalosis
4. Electrolyte abnormalities
5. Excessive catecholamine
6. Autonomic influences
7. Drug toxicity
8. Scarred and diseased tissue

2. Dysrhythmias result from disturbances in impulse formation, disturbances in impulse conduction, or both

3. Most prevalent types of dysrhythmias are

    1. Tachycardia (too fast)
    2. Bradycardia (too slow)

4. Usually caused by an imbalance between the sympathetic and parasympathetic nervous system stimulation.

    1. Excessive parasympathetic stimulation causes bradycardias.

    2. Tachycardias have a variety of causes and are treated with antidysrhythmics.

6. Antidysrhythmics

    1. Used to treat and prevent disorders of cardiac rhythm

    2. Work by a direct action on the cardiac cell membrane (lidocaine), by indirect action that affects the cell (propranolol), or both.

7. Classifications

    1. Based on fundamental mode of action on cardiac muscle

    2. Drugs that belong to the same class do not necessarily produce identical actions

    3. All antidysrhythmics have some ability to suppress automaticity

8. Class I- Sodium Channel Blockers

    1. Class I drugs are subdivided into Classes I-A, I-B, I-C.

        1. Class I-A drugs decrease conduction velocity and prolong the electrical potential of cardiac tissue

            (1) Example: procainamide (Pronestyl)

        2. Class I-B drugs increase or have no effect on conduction velocity

            (1) Increases the rate of repolarization and reduces automaticity in ventricular cells. ─Example: lidocaine (Xylocaine)

(2) Was once used as a prophylactic drug now limited to life threatening dysrhythmias.

3. Class I-C drugs profoundly slow conduction and are indicated only for life-threatening ventricular dysrhythmias—Example: flecainide (Tambocor)

(1) Group I-C drugs are not administered in the prehospital setting.

9. Class II- Beta Blockers

1. Class II drugs are beta-blocking agents that reduce adrenergic stimulation of the heart—Example: propranolol (Inderal)

10. Class III- Potassium Channel Blockers

1. Class III drugs are antiadrenergic agents that have a positive inotropic action (agonist-antagonist)

2. Increases contractility.

1. Unlike other antidysrhythmics, drugs in this group do not suppress automaticity and have no effect on conduction velocity

2. Thought to terminate dysrhythmias that result from reentry of block impulses

3. Example: bretylium tosylate (Bretylol)

11. Class IV Calcium Channel Blockers

1. Thought to work by blocking the inflow of calcium through the cell membranes of the cardiac and smooth muscle cells

2. Depresses the myocardium and smooth muscle contraction

3. Decreases automaticity

4. In some cases, decreases conduction velocity

5. Example: verapamil (Isoptin)

12. Miscellaneous Antidysrhythmics

1. Adenosine (Adenocard)

    1. Does not fit any of the previous categories.

    2. Has a very short half life (about 10 seconds)

    3. Acts on both potassium and calcium channels, increasing potassium efflux and inhibiting calcium influx.

    4. Results in hyperpolarization that effectively slows the conduction of slow potentials.

2. Digoxin (Lanoxin)

    1. Is a paradoxical drug.

    2. Is an effective antidysrhythmic.

    3. A potent prodysrhythmic (Generator of dysrhythmias)

    4. Decreases the intrinsic firing rate of the SA node and decreases velocity of AV node.

    5. Side effects include Bradycardia, AV blocks and PVCs.

3. Magnesium

    1. Drug of choice for Torsade de pointes and other VT refractory to other treatment.

    2. Mechanism of action not known but it may act on sodium or potassium channels or on NA+ K+ ATPase.

26. Antihypertensives

    1. Hypertension affects approximately 50 million Americans and has been directly related to increased incidence of:

        1. Stroke
        2. Cerebral hemorrhage
        3. Heart and renal failure
        4. Coronary heart disease

    2. The ideal antihypertensive drug should

        1. Maintain blood pressure within normal limits for various body positions

2. Maintain or improve blood flow without compromising tissue perfusion or blood supply to the brain

3. Reduce the work load on the heart

4. Have no undesirable side effects

5. Permit long-term administration without intolerance

3. Blood pressure is the force of pressure against the wall of the arteries as the heart contracts and relaxes.

1. Blood Pressure = Cardiac Output X peripheral vascular resistance
2. Cardiac output is equal to the heart rate times the stroke volume:
3. Cardiac Output = Heart Rate X Stroke Volume

4. Starling's Law

1. Pre-Load and Stroke volume are proportionate.

5. Drugs that control hypertension affect pre-load.

6. Classifications

1. Four major categories

1. Diuretics
2. Beta blockers and antiadrenergic drugs
3. Vasodilators
4. Angiotensin-converting enzyme (ACE) inhibitors

2. Calcium channel blockers are also increasingly being used to treat hypertension

3. Diuretics

1. Until recently were considered the initial drug of choice in managing mild hypertension

2. Fluid and/or electrolyte imbalance occurs with increased frequency in patients who take diuretics.

3. Still the drug of choice in treating patients with hypertension and congestive heart failure

4. Result in a loss of excess salt and water from the body by renal excretion

5. The decrease in plasma and extracellular fluid volume (which decreases preload and stroke volume), plus a direct effect on arterioles, results in lowered blood pressure

6. Causes an initial decline in cardiac output, followed by a decrease in peripheral vascular resistance, and a lowering of the blood pressure

4. Loop diuretics

1. Powerful, short-acting agents that inhibit sodium and chloride reabsorption in the loop of Henle

2. Cause excessive loss of potassium and water and an increase in the excretion of sodium

3. Produce fewer side effects than most other antihypertensives

4. Hypokalemia and profound dehydration can result from their use

5. Prescribed to patients who have renal insufficiency or who cannot take other diuretics

6. Example: furosemide (Lasix)

5. Thiazides

1. Diuretics that are moderately effective in lowering blood pressure

2. May be given concomitantly with other antihypertensives to prevent retention of sodium and water

3. Example: hydrochlorothiazide (Hydrodiuril)

6. Potassium-sparing agents

1. Promote sodium and water loss without a potassium loss

2. Used to treat hypertensive patients who become hypokalemic with other diuretics

3. Also used to treat some edematous states such as cirrhosis of the liver with ascites

4. Example: spironolactone (Aldactone)

7. Combinations of diuretic agents may be prescribed to lower blood pressure

1. Usually include hydrochlorothiazide (HCTZ)
2. Example: Aldactazide (HCTZ and spironolactone)

7. Sympathetic Blocking Agents

1. Beta adrenergic Antagonist

1. Used to treat cardiovascular disorders, including hypertension

2. Work by decreasing cardiac output and inhibiting renin secretion from the kidneys (result in lower blood pressure)

3. Compete with epinephrine for available beta-receptor sites

4. Inhibiting tissue and organ response to beta stimulation

8. Beta1-blocking agents (cardioselective)

1. Acebutolol (Sectral)
2. Atenolol (Tenormin)
3. Metoprolol (Lopressor)

9. Beta1 and Beta2-blocking agents (nonselective)

1. Labetalol (Normodyne, Trandate)
2. Nadolol (Corgard)
3. Propranolol (Inderal)

27. Adrenergic inhibiting agents.

1. Work by modifying the sympathetic nervous system and are effective antihypertensive drugs

2. Sympathetic stimulation

1. Increases heart rate and force of myocardial contraction
2. Constricts arterioles and venules
3. Causes the release of renin from the kidneys
4. Blocking this stimulation can reduce blood pressure

3. Centrally acting adrenergic inhibitors

    1. Clonidine hydrochloride (Catapres)
    2. Methyldopa (Aldomet)

4. Peripheral adrenergic inhibitors

    1. Guanethidine sulfate (Ismelin)
    2. Reserpine (Sandril, Serpasil)

5. Alpha1- and Alpha2-blocking agents

    1. Prazosin hydrochloride (Minipress)
    2. Phentolamine (Regitine)
    3. Phenoxybenzamine (Dibenzyline)

28. Combined Alpha/Beta Antagonists

    1. Act directly on the smooth muscle walls of the arterioles, veins, or both

        1. Lowering peripheral resistance and blood pressure

            1. Stimulate the sympathetic nervous system and activate the baroreceptor reflexes

            2. Leading to an increased heart rate, cardiac output, and renin release

            3. Combined therapy is usually prescribed to inhibit the sympathetic response

            4. Also useful in treating angina pectoris

    2. Nitrates dilate veins and arteries

        1. Dilated veins lead to venous pooling and a decreased blood return to the heart

        2. Reducing left ventricular end-diastolic volume and pressure

        3. Decreases myocardial oxygen demand and chest pain associated with ischemia

    3. Arteriolar dilator drugs

        1. Diazoxide (Hyperstat IV)

2. Hydralazine hydrochloride (Apresoline)
3. Minoxidil (Loniten)

4. Arteriolar and venous dilator drugs

    1. Sodium nitroprusside (Nipride, Nitropress)
    2. Nitrates and nitrites

5. Amyl nitrite inhalant

6. Isosorbide dinitrate (Isordil, Sorbitrate)

7. Nitroglycerin (Nitrostat and others)

8. Nitroglycerin paste (Nitro-Bid)

9. Intravenous nitroglycerin

10. Converting enzyme (ACE) inhibitor

29. (ACE) Inhibitor Drugs- Angiotensin Converting Enzyme

    1. The renin-angiotensin-aldosterone system plays an important role in maintaining blood pressure

    2. A disturbance in this system can result in hypertension

    3. Kidney damage can result in an inability to regulate the release of renin, causing an elevated blood pressure

    4. Angiotensin II is a powerful vasoconstrictor

        1. Raises blood pressure and causes the release of aldosterone
        2. Contributes to sodium and water retention

    5. By inhibiting conversion of angiotensin I to the active molecule angiotensin II (brought about by ACE)

    6. The renin-angiotensin-aldosterone system is suppressed, lowering blood pressure

    7. Examples:

        1. Captopril (Capoten)
        2. Enalapril (Vasotec)
        3. Lisinopril (Prinivil)

30. Angiotensin II Receptor Antagonist

    1. Recently developed classification.

    2. Acts on the rennin-angiotensin-aldosterone system.

    3. Achieves the same effects as the ACE inhibitors without the side effects of cough and angioedema

31. Calcium channel blocking agents

    1. Reduce peripheral vascular resistance by inhibiting the contractility of vascular smooth muscle

    2. Dilate coronary vessels in the same manner

    3. Important in

        1. Treating hypertension

        2. Decreasing the oxygen requirements of the heart (through decreased afterload) and increasing oxygen supply by abolishing coronary artery spasm, thus relieving the cause of angina pectoris.

    4. Examples:

        1. Verapamil (Isoptin)
        2. Nifedipine (Procardia)
        3. Diltiazem (Cardizem)

32. Direct Vasodilators

    1. Two specific classes.

        1. Those that dilate arterioles and those that dilate arterioles and veins.

    2. Those that dilate arterioles

        1. Causes decreased peripheral vascular resistance or afterload.

        2. Results in lower BP, increased cardiac output and reduced workload on the heart.

    3. Those that dilates arterioles and veins.

        1. Dilating the veins increases capacitance and decreases pre-load.

2. Decreases both pre-load and cardiac output.

3. Remember Starling's Law

4. Examples:

    1. Selective Arteriole dilators

        (1) Hydralizine (Apresoline) Proto-type drug.
        (2) Minoxidile (Loniten) Marketed as Rogain

    2. Non-Selective Dilators

        (1) Sodiuim nitroprusside (Nipride)

33. Ganglionic blocking agents

    1. Block sympathetic and parasympathetic ganglia

    2. Decrease peripheral resistance, cardiac output, and stroke volume

    3. Are considered to be less safe than other antihypertensive drugs (Are rarely used today)

    4. Examples:

        1. Trimethaphan (Arfonad)
        2. Pargyline hydrochloride (Eutonyl)
        3. Metyrosine (Demser)

34. Cardiac Glycosides

    1. Naturally occurring plant substances that have characteristic actions on the heart.

    2. Contain a carbohydrate molecule (sugar)

    3. When combined with water, is converted into a sugar plus one or more active substances

    4. May work by blocking certain ionic pumps in the cellular membrane

    5. Which indirectly increases the calcium concentration to the contractile proteins

    6. Affect the heart in two ways:

1. They increase the force of contraction (positive inotropic effect)

2. They have a dual effect on the electrophysiological properties of the heart

    1. Modest negative chronotropic effect, causing slight slowing

    2. A more profound negative dromotropic effect, decreasing conduction velocity

3. Digoxin (Lanoxin) is an important cardiac glycoside used to treat heart failure and to manage certain tachycardias.

4. Side Effects

    1. Cardiac glycosides have a small TI

    2. Side effects are common

    3. Symptoms may be neurological, visual, gastrointestinal, cardiac, or psychiatric

    4. Are often vague and easily attributed to a viral illness

    5. Common side effects include:

        (1) Anorexia

        (2) Nausea and vomiting

        (3) Visual disturbances

        (4) Flashing lights

        (5) Altered color vision

        (6) Cardiac rhythm disturbances

            (1) Usually slowing with varying degrees of blocked conduction

        (7) Toxic effects are dose related

            (1) May be increased by the presence of other drugs such as diuretics

        (8) Dysrhythmias may include bradycardias, tachycardias, and

ventricular fibrillation

6. Treatment for digitalis toxicity may include:

(1) Correction of electrolyte imbalances
(2) Neutralization of the free drug
(3) Use of antidysrhythmics

35. Drugs that affect the blood.

1. Knowledge of the drugs that affect blood coagulation and the use of thrombolytic agents is important in prehospital care

1. Blood coagulation

1. A process that results in the formation of a stable fibrin clot that entraps platelets, blood cells, and plasma

2. Results in a blood clot or thrombus

2. Abnormal thrombus formation (intravascular clotting) is a major cause of MI (from coronary thrombosis) and CVA (from cerebral thrombosis)

3. Arterial thrombi are commonly associated with

1. Atherosclerotic plaques

2. Hypertension

3. Turbulent blood flow that damages the endothelial lining of blood vessels

4. Major risk factors for various thromboses

1. Stasis

(1) Results from immobilization or venous insufficiency

(2) Is responsible for increased incidence of deep vein thrombosis (DVT) in most bedridden patients

2. Localized trauma

(1) May initiate the clotting cascade and cause arterial and venous thrombosis

3. Hypercoagulable states

(1) The mechanism behind the increased incidence of DVT in women who take birth control pills

(2) Responsible for many of the familial thrombotic disorder.

2. Agents that Affect Blood Coagulation

1. Antiplatelet agents

1. Drugs that interfere with platelet aggregation

2. Patients who take antiplatelet or anticoagulant drugs at home are at increased risk for life-threatening hemorrhage from trauma.

3. Sometimes prescribed prophylactically for patients at risk for arterial clots and those who have suffered MIs or CVAs

4. Also used to treat certain valvular heart diseases, valvular prosthesis, and various intracardiac shunts.

5. Common antiplatelet drugs

(1) Aspirin
(2) Sulfinpyrazone (Anturane)
(3) Dipyridamole (Persantine)

2. Anticoagulant agents

1. Designed to prevent intravascular thrombosis by decreasing blood coagulability

2. Used to prevent postoperative thromboembolism and during hemodialysis

3. Has no direct effect on a blood clot that is already formed or on ischemic tissue injured as a result of a thrombus

4. Major side effect of therapy is hemorrhage

5. Examples:

(1) Warfarin (Coumadin)
(2) Heparin (Liquaemin)

3. Thrombolytic agents

    1. The use of thrombolytics in the prehospital setting is being studied in several areas of the U.S.

    2. Dissolve drug clots after their formation by promoting the digestion of fibrin

    3. The treatment of choice for treating AMI in certain groups of patients

    4. The goal is to re-establish blood flow and prevent myocardial ischemia and tissue death

    5. Also used to treat acute pulmonary embolism, DVT, and peripheral arterial occlusion

    6. Examples

        (1) Anisoylated plasminogen streptokinase activator (Eminase)
        (2) Streptokinase (Streptase)
        (3) Urokinase (Abbokinase)
        (4) Tissue plasminogen activator (t-PA, Alteplase)

36. Drugs used to affect the Respiratory System

    1. Drugs that affect the respiratory system are useful for several purposes.

        1. Most obvious is the treatment of asthma

        2. Also includes:

            1. Cough suppressants
            2. Nasal decongestants
            3. Antihistamines

    2. The respiratory system includes all structures involved in the exchange of oxygen and carbon dioxide.

    3. Serious narrowing of any portion of the respiratory tract may be an indication for pharmacological therapy

    4. Emergencies involving the respiratory system are usually caused by reversible conditions

        1. Asthma

2. Emphysema with infection
3. Foreign body obstruction

5. Smooth muscle fibers of the tracheobronchial tree directly influence the diameter of the airways

    1. Muscle tone is maintained by impulses from the autonomic nervous system

    2. Parasympathetic fibers from the vagus nerve innervate bronchial smooth muscle through the release of acetylcholine

        1. Interacts with the muscarinic receptors on the membranes on the cell, producing bronchoconstriction

    3. Sympathetic fibers primarily affect beta2-receptors through the release of epinephrine from the adrenal medulla and the release of norepinephrine from the peripheral sympathetic nerves.

        1. Produces smooth muscle relaxation and bronchodilation.

    4. The beta2-receptor plays the dominant role in bronchial muscle tone

        1. Beta1-receptors are also found on bronchial smooth muscle

            (1) Their ratio to beta2 receptors is 1:3

37. Bronchodilator Drugs

    1. The primary treatment for obstructive pulmonary diseases such as asthma, chronic bronchitis, and emphysema

    2. Sympathomimetic Drugs (Beta2 Specific and nonselective sympathomimetics.)

        1. Drugs are grouped according to their receptor action

            1. Nonselective adrenergic drugs have alpha and beta1 (cardiac), and beta2 (respiratory) activities

            2. Nonselective beta-adrenergic drugs have both beta1 and beta2 effects

            3. Selective beta2-receptor drugs act primarily on beta2 receptors in the lungs (bronchial smooth muscle)

        2. Nonselective adrenergic drugs stimulate alpha and beta receptors

1. Alpha activity mediates vasoconstriction to reduce mucosal edema

2. Beta2 activity produces bronchodilation and vasodilation

3. Undesirable effects on beta1 receptors include an increase in heart rate and force of contraction

4. Undesirable beta2 effects include muscle tremors and CNS stimulation

5. Examples:

(1) Epinephrine inhalation aerosol (Bronkaid Mist, Primatene Mist)

(2) Epinephrine racemic (AsthmaNefrin, microNephrin)

3. Nonselective beta-adrenergic drugs are not selective for beta2 receptors and, as a result, have a wide range of effects.

1. Examples:

(1) Epinephrine (Adrenalin) has some alpha activity

(2) Ephedrine (Ephed II) has some alpha activity

(3) Ethylnorepinephrine (Bronkephrine) has some alpha activity

(4) Isoproterenol (Isuprel)

4. The selective action of beta2-selective drugs lessens the incidence of unwanted cardiac effects caused by beta1-adrenergic agents

1. Examples of beta2-selective drugs:

(1) Albuterol (Proventil, Ventolin)
(2) Terbutaline sulfate (Brethine, Bricanyl)
(3) Bitolterol (Tornalate)
(4) Epinephrine (Adrenalin)
(5) Isoetharine (Bronkosol)

2. Better tolerated by patients with hypertension, cardiac disease, or diabetes

3. Methylxanthines (Xanthine Derivatives)

    1. Includes caffeine, theophylline, and theobromine

        1. Relax smooth muscle (particularly bronchial smooth muscle)
        2. Stimulate cardiac muscle and the CNS
        3. Increase diaphragmatic contractility
        4. Promote diuresis through increased renal perfusion

    2. Theophylline products vary in their rate of absorption and therapeutic effects.

        1. No longer a first-line drug in the treatment of reactive airway disease.

        2. Examples of xanthine derivatives:

            (1) Aminophylline (Amoline, Somophyllin)
            (2) Dyphylline (Dilor, Droxine)
            (3) Theophylline (Bronkodyl, Elixophyllin)

38. Other Respiratory Drugs

    1. Other agents used to treat asthma and other obstructive pulmonary diseases include:

    2. Anticholinergics

        1. Also known as Muscarinic antagonists

            1. Ipratropium (Atrovent)
            2. Glycopyrrolate (Robinul)

    3. Glucocorticoids

        1. Aerosol corticosteroid agents

            1. Beclomethasone dipropionate (Vanceril Inhaler, Beclovent)

        2. Injectable corticosteroid agents

            1. Dexamethasone (Decadron)

        3. Prophylactic asthmatic agents

            1. Not a glucocorticoid but its actions are similar.

(1) Cromolyn sodium (Intal, Sodium Cromoglycate)
(2) Often used as in preventing asthma in adults and children.

4. Leukotriene Antagonist

1. Leuktrienes are mediators released from mast cells upon contact with allergens.

(1) Contribute powerfully to both inflammation and bronchoconstriction.

2. Agents that block their effects are useful in treating asthma.

3. Leukotrien antagonist can either block the synthesis of leukotriens or block their receptors.

4. Examples of Leukotriene Antagonist:

(1) Zileuton (Zyflo)

(1) Blocks Synthesis of leukotrienes.

(2) Zafirlukast (Accolate)

(1) Blocks leukotriene receptors.

4. These agents reduce the allergic or inflammatory response to a variety of stimuli.

5. In acute care, IV steroids may be given to decrease the inflammatory response and improve air flow

1. Methylprednisolone (Solu-Medrol)

6. Drugs used for Rhinitis & Cough

1. Nasal Decongestants

1. Caused by dilated and engorged nasal capillaries.

2. Drugs that constrict these capillaries are effective decongestants.

(1) The main pharmacologic classification is alpha-1 agonist.

(2) When overused, can elevate both the pulse and the blood pressure.

2. Antihistamines

1. Histamine is a chemical mediator found in almost all body tissues

(1) Concentration is highest in the skin, lungs, and GI tract

2. The body releases histamine when exposed to an antigen such as pollen or insect stings.

(1) Results in increased localized blood flow, increased capillary permeability, and swelling of the tissues

(2) Produces contractile action on bronchial smooth muscle

(3) Systemic effects may result in anaphylaxis

3. Antihistamines compete with histamine for receptor sites, preventing the physiological action of histamine

(1) H1 receptors act primarily on blood vessels and bronchioles

(2) H2 receptors act mainly on the GI tract

4. Antihistamines also have anticholinergic or atropine-like action

(1) May result in inhibition of secretions, tachycardia, constipation, drowsiness, and sedation

5. Most antihistamines have a local anesthetic effect that may sooth skin irritation caused by an allergic reaction.

6. Antihistamines are used primarily for allergic reactions.

(1) Other uses include treatment for motion sickness or as a sedative or antiemetic.

(2) Examples of antihistamines:

(1) Dimenhydrinate (Dramamine)
(2) Diphenhydramine (Benadryl)
(3) Hydroxyzine (Atarax)
(4) Meclizine (Antivert)
(5) Promethazine (Phenergan, and others)

3. Cough Suppressants

    1. Coughing is a complex reflex that aids in the removal of foreign particles.

    2. In general treating a productive cough is not appropriate.

    3. An unproductive cough usually results from an irritated oropharynx.

    4. Three classifications of cough suppressants.

        (1) Antitussive medications are supported by evidence while Expectorants and Mucolytics are not.

        (2) Antitussive medications.

            (1) Two most common opioid antitussives are codein and hydrocodone.

                1) Both inhibit the stimulus for coughing in the brain.

                2) Produces varying degrees of euphoria.

            (2) The non-opioid antitussives do not have the same potential for abuse.

                1) Examples:

                    1) Dextromethoraphan

                        39. Used in combination products for treating the cold and flu.

                    1) Diphenhydramine (Benadryl)

                        40. Mechanism of action not clear.

        (1) Expectorants

            (1) Medications intended to increase the productivity of the cough.

(2) Mucolytics

(1) Medication intended to make mucus more watery.

41. Drugs used to affect the GI Tract

1. Main indications of drug therapy in the GI System are to treat peptic ulcers, constipation, diarrhea, and emesis, and to aid digestion.

1. Drugs used to treat Peptic Ulcer Disease

1. H2 receptor Antagonist
2. Proton pump inhibitors
3. Antacids
4. Anticholinergics

2. Drugs used to treat constipation.

1. Laxatives

(1) Decrease firmness in stool and increase water content.

(2) Indicated in patients where excessive strain is inappropriate.

(1) Recent episiotomy

(2) Hemorrhoids

(3) Colostomies

(4) Cardiovascular disease where straining may reduce heart rate.

3. Grouped into four categories.

1. Bulk forming (Fiber laxatives)

(1) Absorbs water leading to a softer more bulky stool.

2. Surfactant

(1) Decrease surface tension.

(2) Increases water absorption into the feces.

(3) Also increase water secretion and limit its reabsorption by the intestinal wall.

(1) Example: Docusate sodium (Colace)

3. Stimulant

(1) Increase motility

(2) Also increase water secretion and decrease reabsorption.

(1) Example: Phenolphthalein (Ex-Lax, Correctol)

4. Osmotic

(1) Poorly absorbed salts that increase osmotic pull of feces thereby increasing their water content.

(1) Example: Magnesium hydroxide. (The active ingredient in Milk of Magnesia)

4. Drugs used to treat diarrhea

1. Diarrhea is usually a helpful process because it increases the expulsion of the offending agent.

2. Usually is self correcting.

3. When treatment is necessary, either specific or nonspecific agents may be used.

(1) Specific agents directly treats the cause.

(1) Usually a bacteria.
(2) Antibiotics are common specific antidiarrheal.

5. Drugs used to treat emesis.

1. Emesis involves different parts of the brain as well as receptors and muscles in the stomach and inner ear.

(1) In the brain:

(1) The vomiting center in the medulla.

1) Stimulates vomiting directly.

2) Stimulated by H1 and Ach receptors in the pathway between itself and the inner ear.

(2) Chemoreceptor Trigger Zone. (CTZ)

1) Stimulates the vomiting center in response to stimuli from serotonin receptors in the stomach and blood borne substances such as opioids and ipecac.

2. Antiemitics

(1) Indicated in conjunction with chemotherapy.

(2) Also in prophylactic treatment of motion sickness.

(3) Multiple transmitters are involved in the vomiting reflex.

(1) Serotonin
(2) Dopamine
(3) Acetylcholine
(4) Histamine

(4) Drugs that interfere with any of these transmitters can reduce nausea and vomiting.

3. Serotonin Antagonists

(1) Blocks Serotonin receptors in the CTZ, the stomach and small intestines.

(1) Very effective in treatment of nausea associated with chemotherapy.

(2) Most common side effect is headache and diarrhea.

4. Dopamine Antagonists

(1) Block dopamine receptors in the CTZ.

(2) Butyrophenones

(1) Haloperidol (Haldol)
(2) Droperidol (Inapsine)

(3) Phenothiazines

(1) Prochlorperazine (Compazine)
(2) Promethazine (Phenergan)

(4) Both classes cause side effects of extrpyramidal effects.

5. Cannabinoids

(1) Derivitives of tetrahydrocannabinol (THC)

(1) The active ingredient in marijuana

(2) Effective antiemetics used to treat chemo-therapy induced nausea and vomiting.

(3) Two available agents:

(1) Dronabinol (Marinol
(2) Nabilone (Cesamet)

6. Drugs used to Aid Digestion.

1. Similar to endogenous digestive enzymes.

(1) Examples:

(1) Pancreatin (Entozyme)
(2) Pancrelipase (Viokase)

(2) Side effects are nausea, vomiting and abdominal cramping.

42. Drugs used to affect the eyes.

1. Ophthalmic drugs are used to treat conditions involving the eyes, primarily glaucoma and trauma.

2. Medications used to treat glaucoma are aimed at reducing intraocular pressure (IOP).

1. Beta blockers are most common.

2. Decreases IOP by an unknown mechanism.

1. Examples:

(1) Timolol (Timoptic)

(2) Betaxolol (Betoptic)

(3) Pilocarpine (Isopto Carpine)

(1) Stimulates muscarinic receptors in the eye to cause miosos (pupil constriction) and ciliary contraction which reduces IOP.

(2) Causes blurred vision and local irritation.

3. Medications for trauma and procedures.

1. Tetracain (Pontocaine)

1. Local anesthetic of the ester class.

2. Related to cocain, another ester but not to Lidocain, an amide.

3. Used to decrease pain and sensation in the eye from trauma or during ophthalmic procedures.

4. Caution the patient not to rub his /her eyes because they may worsen the injury.

43. Drugs used to affect the ears.

1. Most drugs are aimed at eliminating underlying bacterial or fungal infections or at breaking up impacted ear wax.

2. Common Antibiotics

1. Chloramphenicol (Chloromycetin Otic)
2. Gentamicin sulfate otic solution (Garamycin)

3. Ear Wax removal.

1. Carbamide peroxide (Auro Ear Drops)
2. Carbamide peroxide and glycerin (Ear Wax Removal System)

4. Some drugs used for other purposes have ototoxic (harmful to the organs or nerves that produce hearing or balance) properties if overdosed or taken to quickly.

1. Aspirin and other NSAIDS

2. Some antibiotics including erythromycin and vancomycin.
3. Furosemide (Lasix)

5. Most common ototoxic symptom is tinnitus.

44. Drugs used to affect the endocrine system

1. The endocrine system transmits information to various regions in the body via blood-borne hormones

2. Hormones act after secretion in the blood stream from endocrine glands

3. Hormones work together to regulate vital processes, including:

1. Secretory and motor activities of the digestive tract
2. Energy production
3. Composition and volume of extracellular fluid
4. Adaption (such as acclimatization and immunity)
5. Growth and development
6. Reproduction and lactation

4. Drugs Affecting the Pituitary Gland

1. Anterior Pituitary Drugs
2. Posterior Pituitary Drugs

5. Drugs Affecting the Parathyroid and Thyroid Glands

1. Parathyroid glands are primarily responsible for regulating calcium levels.

2. Thyroid gland produces thyroid hormones.

1. Plays a vital role in regulating growth, maturation and metabolism.

3. Treatment is aimed at thyroid hormone replacement.

1. Levothyroxine (Synthroid)

(1) A synthetic analogue of T4 (thyroxine)

(1) Overdoses can lead to thyrotoxocosis or thyroid storm.

4. Hyperthyoidism

1. Caused by excessive release of thyroid hormones.

2. Typically as a result of tumors.

3. Most common cause is Graves Disease.

4. Treatment is typically surgical.

(1) Propylthiouracil (PTU) may be given.

6. Drugs Affecting the Adrenal Cortex

1. Two diseases typify the disorders associated with the adrenal cortex:

1. Cushing's disease

(1) Treatment is usually surgical

(2) Symptomatic pharmacologic intervention with antihypertensive (potassium sparing diuretics such as spironolactone [Aldactone] or ACE inhibitors such as captopril [Capoten]) may be necessary.

2. Addison's disease

(1) Treatment aimed at replacement of corticoids.

(2) Drugs of choice are: Cortison (Cortistan) and hydrocortisone (SoluCortef)

7. Drugs Affecting the Pancreas

1. The pancreas is an exocrine gland and an endocrine gland

1. The endocrine portion produces the hormones that enter the circulatory system

2. Hormones of the Pancreas

1. Play an important role in regulating the concentration of certain nutrients in the circulatory system

3. Insulin

1. The primary hormone that regulates glucose uptake by the cells

2. Increases the ability of the liver, adipose tissue, and muscle to take

up and use glucose

(1) Glucose not immediately needed as an energy source is stored in the skeletal muscle, liver, and other tissues as glycogen

4. Glucagon

1. Primarily influences the liver with some effect on skeletal muscle and adipose tissue

2. Stimulates the liver to break down glycogen so that glucose is released into the blood

3. Inhibits the uptake of glucose by muscle and fat cells

5. The balancing action of these two hormones protect the body from hyperglycemia and hypoglycemia.

1. Metabolic derangements can occur in diabetes mellitus

6. Insulin Preparations

1. Comes from one of three sources

(1) Beef
(2) Pork
(3) Synthetic

2. May be classified as natural (regular) or modified to increase their duration

7. Oral Hypoglycemic Agents

1. Used to stimulate insulin secretion from the pancreas in patients with NIDDM.

2. Ineffective in people with Type I diabetes.

3. Four pharmacologic classes:

(1) Sulfonylureas

(1) First class of oral hypoglycemics available.

(2) AKA First or second generation depending on when they were released.

(3) They work by increasing tissue response to insulin.

(4) Major side effect is hypoglycemia.

(5) Examples include:

1) tolbutamide (Orinase)
2) chlorpropamide (Diabinese)
3) glipizide (Glucotrol)
4) glyburide (Micronase)

(2) Biguanides

(1) Decreases glucose synthesis and increases glucose uptake.

(2) Does not stimulate the release of insulin from the pancreas.

(3) Alpha-glucosidase inhibitors

(1) Delay carbohydrate metabolism.

(2) Examples:

1) acarbose (Precose)
2) migliitol (Glyset)

(4) Thiazolidinediones.

(1) New Class of oral hypoglycemic agents unrelated to the others.

(2) Works by promoting tissue response to insulin making the available insulin more effective.

(3) The only drug in this class is troglitazone (Rezulin)

(4) No major side effects.

8. Hyperglycemic Agents

1. Act to increase blood glucose levels.

(1) Glucagon

(1) Indicated for emergency treatment of hypoglycemia.

(2) Frequently given IM

(3) Ocassional side effects are nausea and vomiting, and rarely, allergic reactions.

(2) Dextrose 50% (D50)

(1) Dilute D50 to D25 for administration to pediatric patients.

(2) Primary side effect is tissue necrosis if infiltration occurs.

(3) Thiamine (vitamin B1)

8. Drugs affecting the female reproductive system.

1. Estrogens and Progestins

1. Principle indication of estrogen is replacement therapy.
2. Conflicting data regarding risk verses benefits.
3. Side effects include, nausea, fluid retention, and breast tenderness.

2. Oral Contraceptives

1. Prevents ovulation.

2. Second most popular means of birth control.

3. Many different preparations.

4. May be classified by their administration cycle.

(1) Monophasic
(2) Biphasic
(3) Triphasic

3. Uterine Stimulants and relaxants

1. Uterine stimulants

(1) Also known as oxytcics (meaning rapid birth)

(2) Administered to induce labor and to treat postpartum hemorrhage.

(3) Oxytocin is available commercially as Pitocin and Syntocinon.

(4) Side effect: Water Retention.

2. Uterine relaxants

(1) Also known as tocolytics.

(2) Acts by stimulating beta-2 receptors in the uterus.

(3) The two beta-2 agonists commonly used for this purpose are:

(1) Terbutaline (Brethine)
(2) Ritodrine (Yutopar)

4. Infertility Agents

1. Are developed for women and promote maturation of ovarian follicles.

2. Examples:

(1) Clomiphene (Clomid)
(2) Urofollitropin (Metrodin)
(3) Menotropins (Pergonal)

3. Each act by a different mechanism.

4. These agents' side effects include:

(1) Ovarian enlargment or cyst
(2) Abdominal pain
(3) Menstrual irregularities.

9. Drugs Affecting the Male reproductive system.

1. Includes drugs that treat testosterone deficiency and benign prostatic hyperplasia.

2. Testosterone replacement therapy may be indicated in deficiency caused

by:

1. Cryptorchidism (failure of one or both of the testes to descend during puberty)

2. Orchitis (testicular inflammation)

3. Orchidectomy (testicular removal)

4. Also may be used in delayed puberty.

3. Examples include:

1. testosterone enanthate
2. methyltestosterone (Metandren)
3. fluoxymesterone (Halotestin)

4. Benign prostatic hyperplasia.

1. Enlarged prostate.

2. Common age-related disease.

3. Several drugs available.

(1) Finasteride (Proscar)

4. Side effects include:

(1) Rash
(2) Breast tenderness
(3) Headache
(4) Impotence
(5) Decreased libido.

10. Drugs Affecting Sexual Behavior

1. Many drugs decrease libido. Mostly as a side effect.

2. Examples include:

1. Antihypertensives (beta-blockers, centrally acting alpha antagonists, and diuretics)

2. Antianxiety/ antipsychotic medications (benzodiazopines, phenothiazines, MAO inhibitors and tricyclic antidepressants).

3. Many drugs are said to increase libido.

    1. Most notable is cantharis (Spanish fly).

    2. LSD, marijuana and alcohol also believed to heighten sexuality.

        (1) Most likely an indirect result of decreased inhibitions.

        (2) Have no proven direct physiological effect on sexual gratification.

4. Levodopa (L-dopa) has demonstrated increased libido and improved erectile ability as a side affect of treatment.

5. Sildenafil (Viagra)

    1. Approved in 1998 for pharmacologic therapy.

    2. Acts by relaxing vascular smooth muscle, which increases blood flow to the corpus cavernosum. (The sponge like tissue on the sides of the penis).

    3. Has no effect in the absence of sexual stimulation.

    4. Chief side effect seen when used in combination with nitrates.

        (1) Combined effect of relaxing vascular smooth muscle may lead to a dangerously decreased preload leading to myocardial infarction.

        (2) Do not give nitroglycerin to patients who have recently taken sildenafil.

45. Drugs used to treat cancer.

    1. Called antineoplastic agents.

    2. Grouped according to their mechanism of action.

        1. Antimetabolite drugs

            1. Mimic some enzymes and proteins needed for DNA production but do not have the same effects.

            2. Therefore they prevent cells from reproducing.

3. Prototype drug is fluorouracil (Adrucil).

2. Alkylating agents.

1. Interfere with DNA splitting.

2. Examples:

(1) Cyclophosphamide (Cytoxan)
(2) Mechlorethamine (Mustargen)

3. Mitotic inhibitors

1. Interfere with cell division.

2. Examples:

(1) Vinblastine (Velban)
(2) Vincristine (Oncovin)

3. Almost all antineoplastic agents cause severe side effects and are given in conjunction with antiemetics.

46. Drugs used to treat infectious Diseases and inflammation

1. Antibiotics

1. May either kill the offending bacteria (bactericidal agents) or decrease the bacteria's growth to the point that the body's immune system can effectively fight the infection (bacteriostatic agents).

2. In general, all share one of several mechanisms.

1. Bactericidil agents act by inhibiting cell wall synthesis of the bacteria cell.

2. Osmotic pressure pulls water into the cell causing cell rupture.

3. Includes the penicillin and cephalosporin classes as well as vancomycin (Vancocin)

2. Antifungal and Antiviral Agents

1. Fungal infections (mycoses) may be treated with several drugs.

2. Azole antifungals inhibit fungal growth.

    1. Prototype drug is ketoconazole (Nizoral)

3. Drugs used to treat viruses work by a variety of mechanisms.

    1. Includes acyclovir (Zovirax) and zidovudine (Retrovir)

        (1) Commonly known as AZT.

    2. Protease inhibitors are one of the more promising classes for treating viruses such as HIV.

        (1) Prototype drug, Indinavir (Crixivan)

3. Other Antimicrobial and Antiparasitic Agents

    1. Schizonticides

        1. Includes:

            (1) Chloroquine (Aralen)
            (2) Mefloquine (Lariam)
            (3) Quinine

        2. Antiparasitics used to treat Malaria

        3. Treatment is aimed at either preventing infestation or killing the parasites in infected patients.

    2. Drug commonly used to treat tuberculosis.

        1. Includes:

            (1) Isoniazide (Nydrazid, INH)
            (2) Rifampin (Rifadin)

    3. Drugs used to treat amebiasis.

        1. A parasitic infection of the intestines common in tropical areas.

        2. Includes:

            (1) Paromomycin (Humatin)
            (2) Metronidazole (Flagyl)

4. Drugs to treat helminthiasis

    1. Caused by parasitic worms

    2. Including flatworms and roundworms.

    3. Treatment is aimed at killing the organism or destroying its ability to latch to the intestinal wall.

    4. Examples:

        (1) Mebendazole (Vermox)
        (2) Niclosamide (Niclocide)

5. Drugs used to treat Hansen's Disease (Leprosy)

    1. Caused by bacteria.

    2. Leads to lesions, footdrop (plantar flexion) and plantar ulceration.

    3. Examples:

        (1) Dapsone (DDS, Avlosulfon)
        (2) Clofazimine (Lamprene)

4. Nonsteroidal Anti-Inflammatory Drugs

    1. Commonly used as analgesics and antipyretics (fever reducers)

    2. Including acetaminophen and ibuprofen.

    3. Other NSAIDS include

        1. ketorolac (Toradol)
        2. piroxicam (Feldene)
        3. naproxen (Naprosyn)

5. Uricosuric Drugs

    1. Used to treat and cure acute episodes of gout.
    2. Includes colchicines and allopurinol (Zyloprim)

6. Serums, Vaccines, and Other Immunizing Agents

    1. Serums and vaccines may augment the immune system.

2. A serum is a solution containing whole antibodies for a specific pathogen.

3. A vaccine contains a modified pathogen that does not actually cause the disease but stimulates the development of antibodies.

    1. These pathogens may be either dead or attenuated (having a decreased disease causing ability).

7. Immune Suppressing and enhancing agents.

    1. Can either suppress the immune system (immunosuppressants) or enhance it (immunomodulators).

    2. Suppressing the immune system is indicated to prevent the rejection of organs transplanted.

    3. Commonly used: Azathioprine (Imuran)

        1. Acts by decreasing cell mediated reactions and suppressing antibody production.

47. Drugs used to affect the skin.

    1. Used to treat skin irritations.

        1. Many different general preparations.

        2. Include:

            1. baths
            2. soaps
            3. solutions
            4. cleansers
            5. emollients (Lubriderm, Vaseline)
            6. skin protectants (Benzoin)
            7. wet dressings or soaks (Domeboro Powder)
            8. rubs and liniments (Ben-Gay, Icy Hot)

48. Drugs used to supplement the diet

    1. Dietary supplements can help to maintain needed levels of these essential nutrients and fluids.

    2. Vitamins & Minerals

        1. Are inorganic compounds necessary for different physiologic processes.

1. Metabolism
2. Growth
3. Development
4. Tissue Repair

2. Most are absorbed in the GI tract.

3. Vitamins are either fat or water soluble.

1. Fat soluble vitamins

(1) A, D, E, and K.
(2) Stored by the liver.

2. Water soluble vitamins

(1) C and those in the B complex
(2) B1 is also known as Thiamin.

4. Essential minerals

1. Most common supplements are Iron.
2. Necessary for oxygen transport.

49. Drugs used to treat poisoning and overdoses

1. Treatment depends on the substance involved.

2. In general, therapy aims at eliminating the substance by emptying the gastric contents.

3. Actual antidotes are few.

4. Some medications are effective in treating certain overdose or poisonings.

1. General mechanism for antidote action include:

1. Receptor site antagonism, blocking enzyme actions involved with metabolism of the substance.

2. Chelation (binding the substance with a stable compound such as iron so that it becomes inactive).